NHDOT SPR2 PROGRAM

RESEARCH PROGRESS REPORT

Project # SPR 26962U		**Report Period** Year 2020 ☐Q1 (Jan-Mar) ☐Q2 (Apr-Jun) XQ3 (Jul-Sep) ☐Q4 (Oct-Dec)
Project Title: Improved Practices for Determining the Infiltration Characteristics of Soils for Design of Stormwater BMPs		
Project Investigator: Jean Benoit, PhD **Phone:**		**E-mail:** jean.benoit@unh.edu
Project Start Date: April 17, 2019	**Project End Date:** June 30, 2021	**Project schedule status:** ✓ On schedule ☐ Ahead of schedule ☐ Behind schedule

Brief Project Description:

Soil infiltration data are utilized by the NH Department of Transportation (NHDOT) to assess the suitability of a site for various stormwater best management practices (BMPs) and to properly size and design a treatment area. With the recent issuance of EPA's final Municipal Separate Storm Sewer System (MS4) permit rules, the need for such testing is expected to increase.

In order to estimate infiltration rates, the NHDOT currently utilizes a variation of the borehole infiltration test prescribed in the NH Department of Environmental Services (NHDES) Alteration of Terrain (AoT) rules using conventional geotechnical drilling equipment. Existing testing protocols are labor intensive and time consuming, often taking 4 hours or more to complete a single test interval (depth). This is particularly inefficient if multiple depths require testing, e.g. if the preferred "bottom of practice" has not been established. In addition, the existing test method may not replicate field conditions and is prone to missing important features in the soil profile. Other available tests either require a constant head that is difficult to maintain in the field or have limitations associated with the effective depth of the test or the level of the groundwater table. Research is needed to evaluate alternative methods and improve Department practices to allow for more effective design of BMPs.

A permeafor device, originally developed in France, has been identified as a potential alternative to current practice. The permeafor is an in-situ hydraulic profiling tool that provides a quick estimate of the permeability profile of soil layers and can be adapted to conventional drilling equipment.

The objectives of this research are as follows:

1. Review available permeafor drawings, adapt design features to be compatible with NHDOT equipment and operations, and fabricate a prototype for further evaluation in the field.
2. Compare the performance of the permeafor alongside existing test method.
3. Recommend and implement design modifications as a result of initial testing.
4. Provide a workable permeafor device suitable for implementation on NHDOT projects.

The scope of work for this research includes the following major tasks, with primary responsibility indicated in parentheses:

1. Obtain available permeafor plans, shop drawings, and details. (UNH)
2. Recommend design changes to ensure compatibility with geotechnical drilling equipment operated by the NHDOT. (UNH/NHDOT)
3. Fabricate one or more permeafor devices. A total of two (2) devices are anticipated as part of the research. It is suggested that a single device be fabricated for initial testing and the second device be fabricated to incorporate lessons learned after the initial testing. (UNH)
4. Procure required pumps, flowmeters, and other ancillary equipment. (UNH)
5. Calibrate the permeafor with grain-size analyses and permeability water tests performed in the laboratory. (UNH)
6. Identify field sites for testing. A minimum of three (3) sites will be evaluated, with multiple depths tested at each site. Sites will be chosen where NHDOT-obtained infiltration data has been collected or will be collected during the research. (UNH/NHDOT)
7. Conduct initial field testing at one or two sites. (UNH/NHDOT)
8. Review existing formula(s) used to convert field data to the Design Infiltration Rate needed for BMP design. (UNH)
9. Conduct final field testing at remaining sites. (UNH/NHDOT)

10. Recommend modifications to formula(s) used to convert field data to the Design Infiltration Rate needed for BMP design. (UNH)

11. Provide a final report summarizing the research and containing recommendations for implementation by NHDOT. (UNH)

Progress this Quarter (include meetings, installations, equipment purchases, significant progress, etc.):

The methods used to determine hydraulic conductivity from data acquired during permeafor testing has continued to be investigated. The NHDOT was able to schedule one additional day of testing on August 28th, located on a private site off Route 125 in Kingston, just north of the Plaistow town line. This additional day of testing will further help the investigation of water flows from the perforated section in the permeafor into granular soils. From this one day of testing, eight permeafor tests were conducted averaging about 20 minutes per test. This allowed for a full hydraulic conductivity profile, down to 17 feet below the ground surface, to be developed for the site. Laboratory tests will also be conducted on samples collected from this site for classification and comparison to the permeafor hydraulic conductivity estimates, similarly to the samples collected in Merrimack. Reports on each testing location are in progress, which will be incorporated into the final report. Due to the limited field-testing performed to date and the lack of availability of drilling support, finite element analysis of the borehole infiltration test has been initiated using Plaxis. Performing these analyses gives a better understanding to how exactly water flows into a soil formation out of the various permeafor test configurations and how it may affect estimated hydraulic conductivity values.

Items needed from NHDOT (i.e., Concurrence, Sub-contract, Assignments, Samples, Testing, etc…):
We will need further drilling support at additional test sites to continue our field investigation using the permeafor. We anticipate testing at sites having different geological profiles to expand and explore the capability of the test method.

Anticipated research next three (3) months:
We are planning to do additional field testing based on the availability of the DOT drilling rigs and staff to support our efforts. We hope that significant testing can occur during the next few months to obtain more data before the winter months, which will be needed to support our initial program objectives to demonstrate the applicability of the permeafor in practice for BMP design.

We are continuing with reviewing the various existing empirical relationships for data analysis using the data acquired during permeafor testing to-date and we continue to develop sections of the final report. Finite element modeling, for both the borehole infiltration test and the permeafor test, will continue to investigate how flow out of the permeafor can be reliably related to hydraulic conductivity.

Circumstances affecting project:
Availability of NHDOT drilling equipment and personnel have been an issue in allowing us to make significant progress in our work. While we understand the reasons and circumstances behind this lack of support, we need to find an alternative solution to allow us to test more sites with various geological conditions. One possible solution is to forego the construction of the second permeafor probe and support equipment and use these funds to hire an outside drilling contractor. This maybe the only solution to ensure successful project completion.

Tasks (from Work Plan)	Planned % Complete	Actual % Complete
Task 1: Permeafor plans	*100*	*100*
Task 2: Permeafor – drill rig compatibility	*100*	*100*
Task 3: Permeafor probes construction	*50*	*50*
Task 4: Ancillary equipment purchases and assembly	*50*	*50*
Task 5: Permeability tests in laboratory	*50*	*35*
Task 6: Site selection	*50*	*35*
Task 7: Conduct initial testing	*100*	*100*
Task 8: Review of existing formulas for analysis	*70*	*70*
Task 9: Conduct final testing	*40*	*40*
Task 10: Recommendations	*0*	*0*
Task 11: Final report	*50*	*50*

Barriers or constraints to implementing research results
None